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SUBJECT—

TITLE

Part I

FIELD ASSESSMENT OF DDT/OIL CONTAMINATION DENSITY FOR THE CONTROL OF THE PINE REPRODUCTION WEEVIL CYLINDROCOPTURUS EATONI. BUCH.

Part II

BIO-ASSAY OF THE RESIDUAL EFFECT OF DDT FOR THE CONTROL OF THE PINE REPRODUCTION WEEVIL, CYLINDROCOPTURUS EATONI BUCH.

by

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PART I

FIELD ASSESSMENT OF DDT/OIL CONTAMINATION DENSITY FOR THE CONTROL OF THE PINE REPRODUCTION WEEVIL CYLINDROCOPTURUS EATONI, BUCH

Introduction

The following investigation was undertaken for the purpose of determining the cheapest and most efficient method of application of DDT/oil sprays for the control of the Pine reproduction weevil, Cylindrocopturus eatoni, Buch. This preliminary report is concerned only with the assessment of DDT/oil sprays from aircraft, the Buffalo turbine sprayer, the High Fog, and Hudson handsprayers.

Assessment of the chemical agent contamination density was done by the dye-tracer method and by the Hoskins method.

Droplet-size determinations were made with all types of applications mentioned above with the object in mind to correlate, if possible, droplet size to deposit and hence to toxicity.

Equipment

A description of the equipment used with construction details will be dealt with elsewhere.

Materials

In field experiment #1 using aircraft the charging containing DDT was made up in the following manner: 50 lbs. DDT were dissolved in 10 gallons of xylene and diluted with 40 gallons of fuel oil #2. After the addition of 0.5 lbs. oil Red dye the solution was filtered. This charging contained approximately 15% DDT (wt./wt.) and 0.125% dye. The density of the charging was 0.84.

In field experiment #2, Trial 1, 25 lbs. DDT were dissolved in 10 gallons of xylene and diluted with 40 gallons of fuel oil #2. After the addition of one lb. Oil Red dye, the solution was filtered. This charging contained 7.5% DDT (wt./wt.) and approximately 0.25% dye. The density of the charging was 0.83.

In experiment #2. Trial 2, kerosene was substituted for fuel oil #2.

In experiment #2, Trial 3, a water emulsion of DDT was prepared in the following manner: 25 lbs. DDT were dissolved in 10 gallons of xylene to which were added 4 pints of Triton X-155 and diluted with 40 gallons of water. This charging contained approximately 6.5% DDT.

In experiment #3 using Hudson and Brown hand sprayers the same formulae as in experiment #2 were used.

Procedure

Inexperiment #1 the aircraft was charged with 50 gallons of spray. The spray was emitted when the aircraft was flying crosswind to the sampling layout. The aircraft flew at a speed of 60-80 mi/hr. and at a mean height of 30 feet above ground, emitting the spray over a swath 100 feet wide.

The chargings were sprayed over a layout containing filter paper (4 inches in diameter) glass plates (3" x 2") and microscope slides provided with troughs 3/4" in diameter and 1/4" deep for collecting spray droplets. The troughs were filled with a solution consisting of 1 part triethanolamine, 1 part oleic acid, 4 parts glycerine and 4 parts water.

The sampling assemblies were placed on stands 3 feet above ground, or just above the brush, and were put down in 3 rows, 30 feet apart, so as to cover the width of the swath, and at 30 yard intervals. A total of 30 samples of each of the filter paper and glass plates and 10 samples of the slides for collecting droplets were taken.

Assessment of the density of deposit was made on the basis of the amount of dye deposited on each filter paper. The dye was extracted with 10 cc. of xylene-kerosene mixture and measured against standard dye solutions with the Dubosq colorimeter addording to Beer's Law where $C_1L_1 = C_2L_2$ and C_2 (the concentration of the unknown) $= \frac{C_1L_1}{L_2}$. This value was then calculated in lbs./acre.

Assessment of the density of deposit on the glass plates was made by chemical analysis of the amount of DDT per slide by the Hoskins method involving washing off the deposit from the slides with benzene, extracting the DDT, and determining the residue by total chloride.

The Hoskins method was also used in the analysis of deposit on Manzanita and pine leaves.

Data on droplet size was obtained by microscopic counting and measuring 400-500 droplets in each sample. The volume of each particular size of droplet was then computed and this was multiplied by the number of droplets of that particular size.

The volume percent of the total number of droplets of each size was then calculated from the total volume and this was plotted graphically.

Results

TABLE I. - Analysis of deposit by the dye-tracer method for aircraft application.

Sample No.	Area (in.2)	C_1	L_1	L_2	C_2	Deposit lbs/acre	Recovery %
A_1 (double dose)	12.5	2×10^{-6}	7	21	6.6×10^{-6}	.800	40.0
A_2	"	"	7	29	4.8×10^{-6}	.580	58.0
A_3	"	"	7	30	4.6×10^{-6}	.558	55.8
A_4	"	"	7	34	4.0×10^{-6}	.480	48.0
A_5	"	"	10	30	3.3×10^{-6}	.400	40.0

TABLE II. - Chemical analysis of deposit by the Hoskins method for aircraft application.

Sample No.	No. of slides	Mgs. DDT	Mgs./Slide	Deposit lbs.acre	Recovery %
A_1 (double dose)	4	1.90	0.47	1.180	59.0
A_2	3	0.38	0.13	.327	32.7
A_3	6	1.43	0.24	.603	60.3
A_4	4	0.54	0.14	.352	35.2
A_5	4	0.28	0.07	.176	17.6
A_6	5	0.83	0.16	.403	40.3

Sample	Weight	Mgs. DDT	PPM
Manazanita leaves	81.66 gms.	24.4	302
Pine leaves	81.74 gms.	0.81	10

TABLE III. - Analysis of deposit by the dye tracer method for the Buffalo turbine application

Sample Number	Distance from sprayer (ft.)	Area ($in.^2$)	C_1	L_1	L_2	C_2	Deposit lbs/acre	Recovery %
T_1 (Diesel)	30	12.5	$1x10^{-5}$	7	30	$2.3x10^{-5}$	.700	70.0
T_2 "	50	"	$2x10^{-6}$	20	22	$1.08x10^{-5}$	.325	32.5
T_3 "	100	"	"	20	30	$.79x10^{-5}$	.239	23.9
T_4 (Kerosene)	25	"	$1x10^{-5}$	12	17	$4.2x10^{-5}$	1.275	127.5
T_5 "	65	"	$2x10^{-6}$	7	14	$.60x10^{-5}$	.183	18.3
T_6 "	150	"	"	7	25	$.33x10^{-5}$	.102	10.2

TABLE IV - Chemical analysis of deposit by the Hoskins method for the Buffalo turbine application

Sample number	Distance from sprayer (ft.)	No. of Slides	Mgs. DDT	Mgs/slide	Deposit lbs/acre	Recovery %
T_1 (Diesel)	30	3	0.72	0.24	.604	60.4
T_2 "	50	4	0.41	0.10	.251	25.1
T_3 "	100	4	0.24	0.06	.151	15.1

TABLE V - Measurement of droplet size spectrum for Aircraft application

Diameter (microns)	No. of droplets	% droplets	Volume	Volume %
3	145	4.8	2,047	0.05
6	363	12.1	41,019	1.07
9	468	15.6	177,372	4.62
12	544	18.1	488,512	12.75
15	403	13.4	707,265	18.55
18	150	5.0	454,800	11.96
21	79	2.6	380,464	9.92
24	63	2.1	452,844	11.85
27	26	0.8	266,110	6.93
30	20	0.6	280,800	7.33
36	10	0.3	242,610	6.34
42	3	0.1	114,015	3.00
48	4	0.14	210,600	5.50
	3000		3,818,458	99.87

Droplet size distribution for N3N aircraft
Diesel-Xylene-DDT

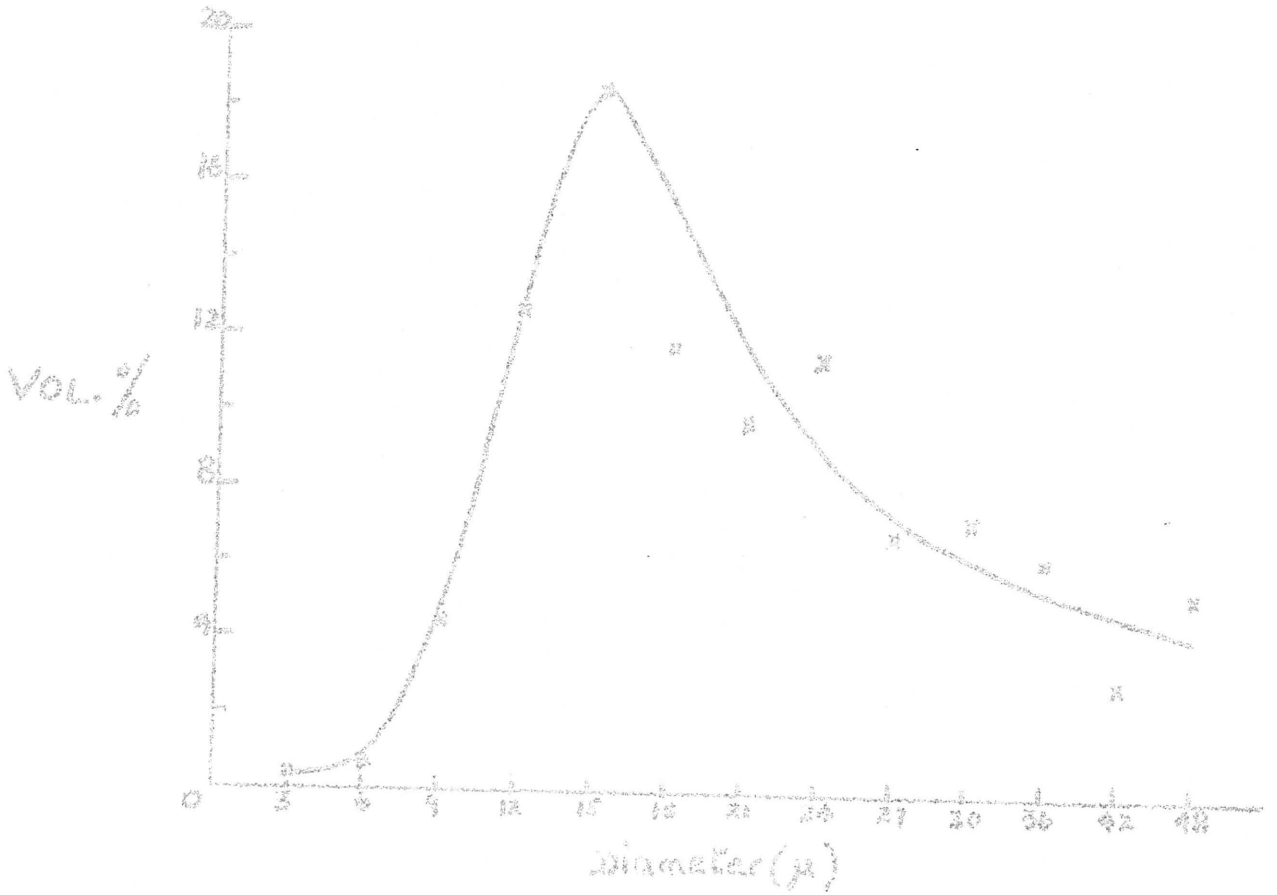


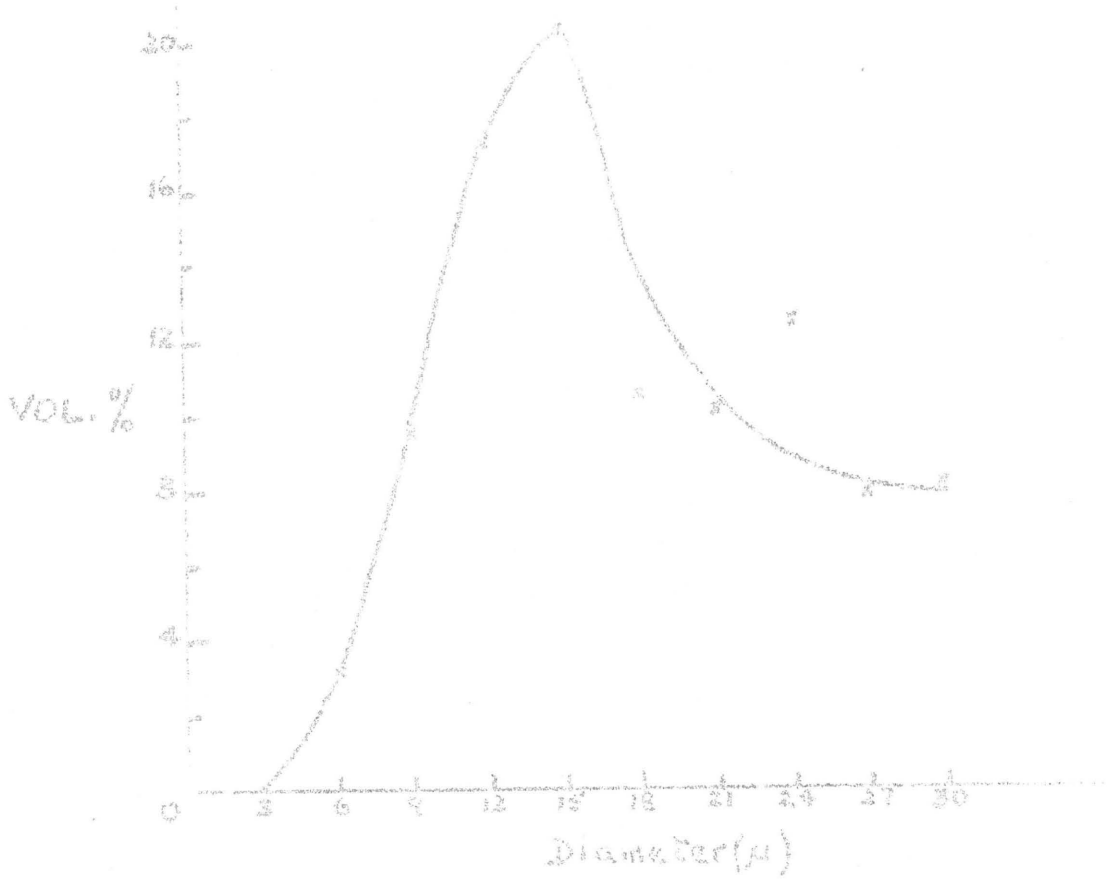
TABLE VI - Measurement of droplet size spectrum for Buffalo turbine application of Diesel-Xylene-DDT
(Distance 35 feet from sprayer)

Diameter (microns)	No. of droplets	% droplets	Volume	Volume %
3	43	8.1	607.16	0.11
6	150	28.3	16,944.00	3.28
9	130	24.5	49,270.00	9.53
12	100	18.8	89,850.00	17.37
15	60	11.3	105,300.00	20.35
18	18	3.4	54,568.80	10.55
21	11	2.0	52,972.70	10.24
24	9	1.7	64,696.50	12.50
27	4	0.7	40,940.00	7.91
30	3	0.6	42,120.00	8.14
TOTALS	530		517,269.16	99.98

TABLE VII - Kerosene-Xylene-DDT
(Distance 35 feet from sprayer)

Diameter (microns)	No. of droplets	% droplets	Volume	Volume %
3	10	3.0	141.20	0.01
6	41	12.4	4,631.36	0.43
9	36	10.9	13,644.00	1.26
12	34	10.3	30,549.00	2.83
15	34	10.3	59,670.00	5.53
18	27	8.2	81,880.20	7.58
21	20	6.0	96,314.00	8.91
24	24	7.2	172,524.00	16.00
27	15	4.5	153,525.00	14.21
30	9	2.7	126,360.00	11.70
36	5	1.5	121,305.00	11.24
42	3	0.9	114,017.10	10.56
48	2	0.6	115,014.00	10.66
TOTALS	260		1,089,576.46	100.8

Droplet size distribution for Buffalo Turbine
Diesel-Xylene-DDT
Distance - 35 feet from sprayer



Droplet size distribution for Buffalo Turbine
Kerosene-Xylene-DDT
Distance - 35 feet from sprayer

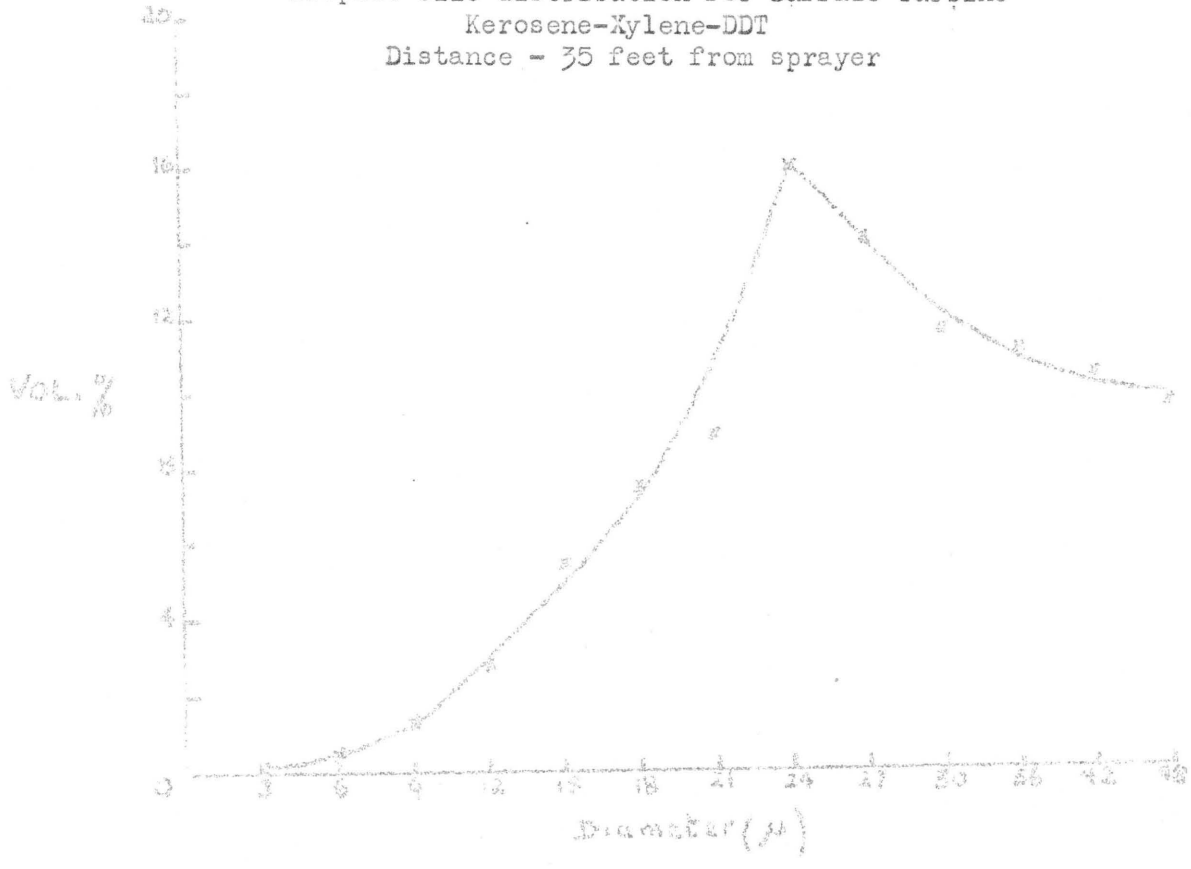


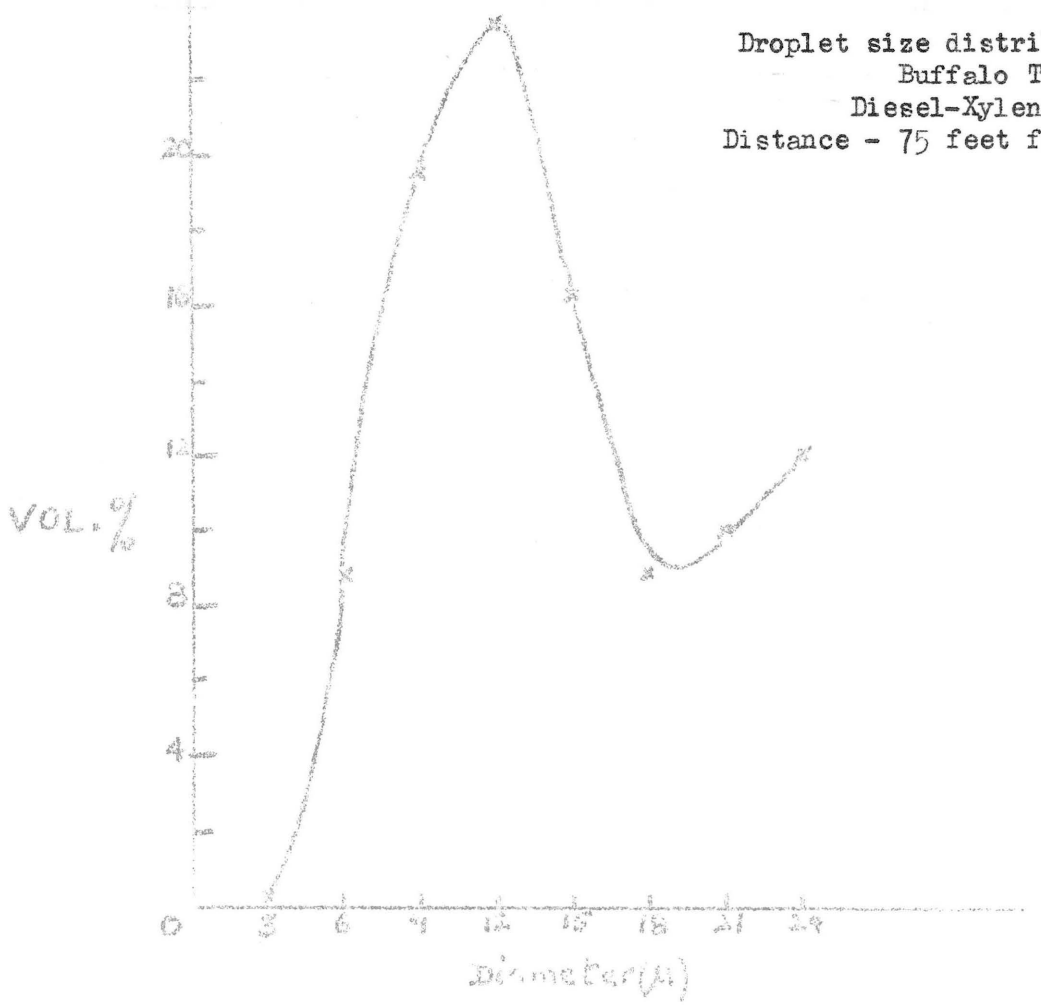
TABLE VIII- BUFFALO TURBINE. Diesel-Xylene-DDT.
Distance 75 feet from sprayer.

Diameter (microns)	No. of droplets	% droplets	Volume	Volume %
3	63	13.7	899.56	0.37
6	185	40.2	20,897.60	8.80
9	123	26.7	46,617.00	19.68
12	51	11.0	55,823.50	23.56
15	22	4.8	38,610.00	16.28
18	7	1.5	21,228.20	8.90
21	5	1.1	24,078.50	10.16
24	4	0.8	28,754.00	12.13
TOTALS	460		236,908.36	99.88

TABLE IX - BUFFALO TURBINE - Kerosene-Xylene-DDT.
Distance - 75 feet from sprayer.

Diameter (Microns)	No. of droplets	% droplets	Volume	Volume %
3	42	9.3	593.00	0.12
6	130	28.8	14,690.00	3.00
9	107	22.6	40,553.00	8.36
12	56	12.4	50,316.00	10.28
15	51	11.3	89,505.00	18.35
18	30	6.6	90,978.00	18.60
21	19	4.2	43,341.30	8.86
24	12	2.6	51,406.00	10.56
27	3	0.6	30,705.00	6.22
30	3	0.6	42,120.00	8.61
36	1	0.2	24,261.00	5.16
TOTALS	450		489,063.30	98.12

Droplet size distribution for
Buffalo Turbine
Diesel-Xylene-DDT
Distance - 75 feet from sprayer



Droplet size distribution for
Buffalo Turbine
Kerosene-Xylene-DDT
Distance - 75 feet from sprayer

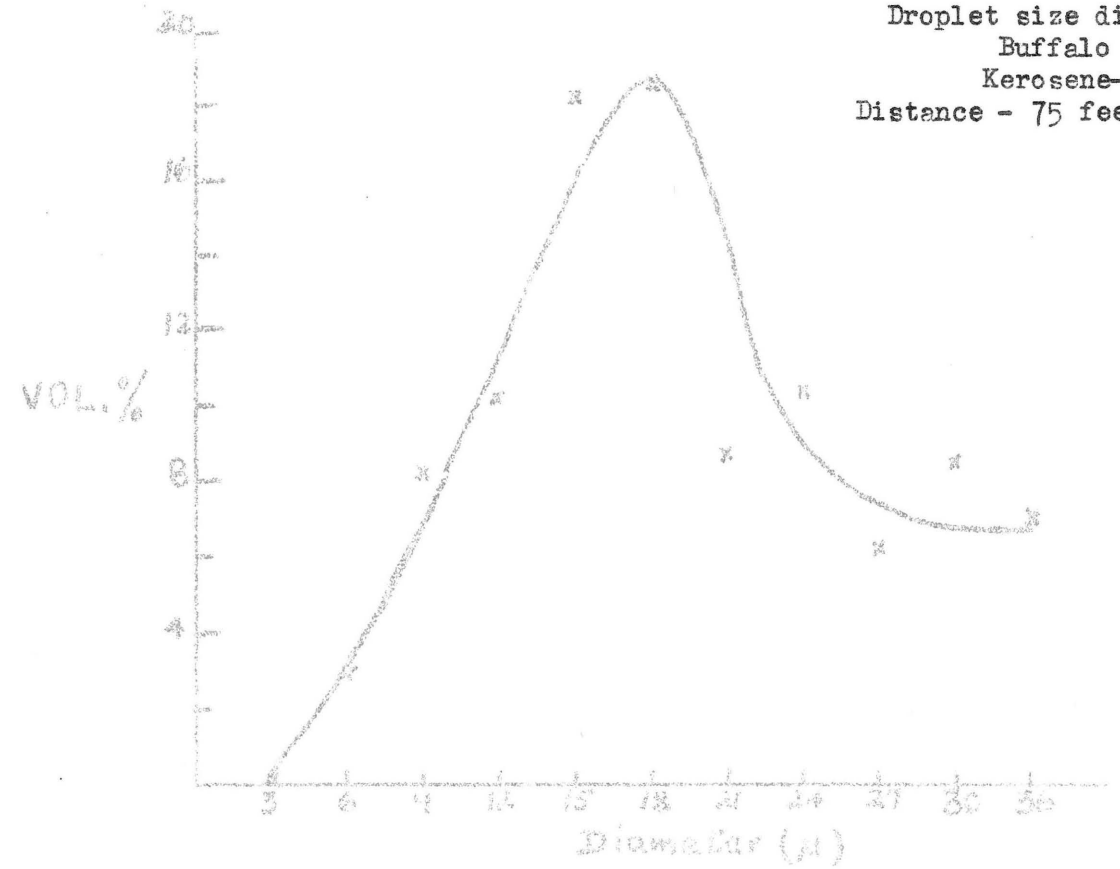


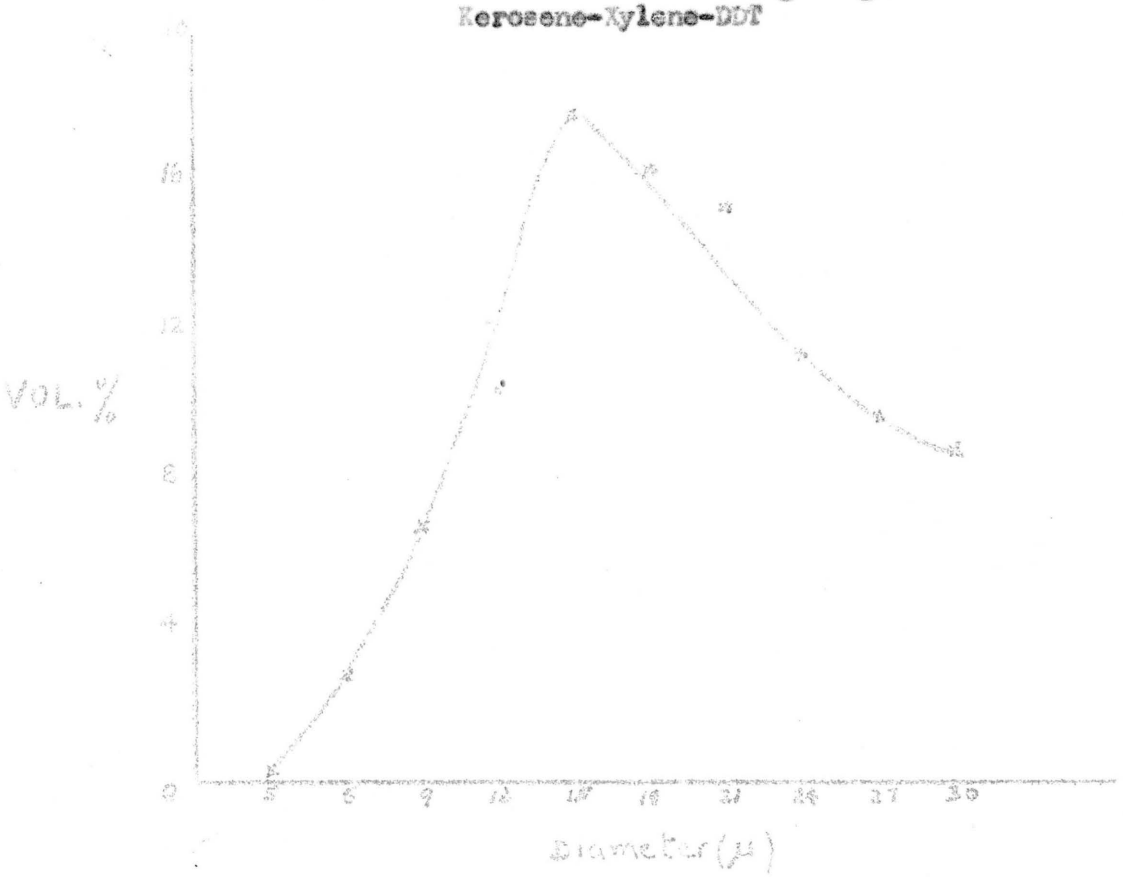
TABLE X - Measurement of droplet size spectrum for High Fog #60. Kerosene-Xylene-DDT

Diameter (microns)	No. of droplets	% droplets	Volume	Volume %
3	56	18.6	790.72	0.25
6	78	26.0	8,810.88	2.82
9	58	19.3	21,982.00	6.93
12	37	12.3	33,244.50	10.53
15	32	10.6	56,160.00	17.86
18	17	5.6	51,554.60	16.33
21	10	3.3	48,157.00	15.26
24	5	1.6	35,942.50	11.35
27	3	1.0	30,705.00	9.72
30	2	0.7	28,080.00	8.80
TOTALS	288		315,427.20	99.88

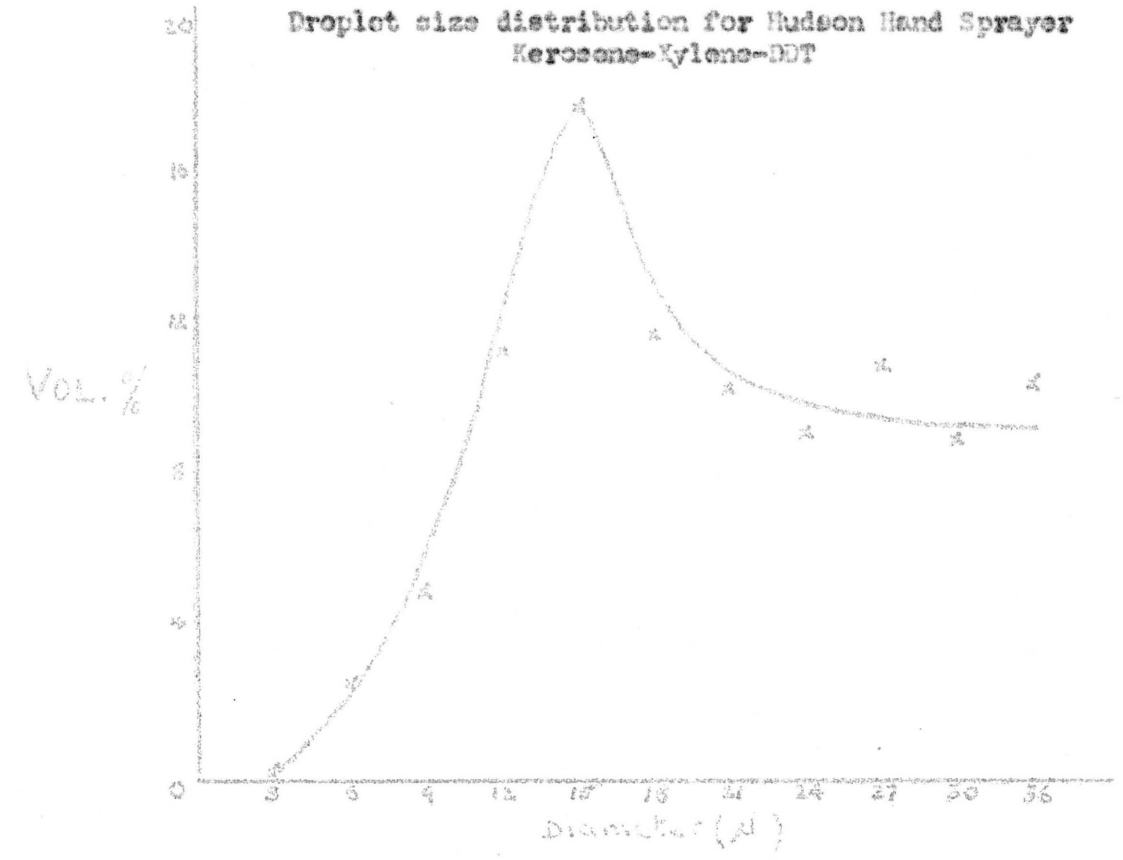
TABLE XI - Measurement of droplet size spectrum for Hudson hand-sprayer. Kerosene-Xylene-DDT.

Diameter (microns)	No. of droplets	% droplets	Volume	Volume %
3	68	17.0	960.16	0.20
6	105	26.2	11,860.80	2.57
9	62	15.5	23,498.00	5.10
12	59	14.7	53,011.50	11.52
15	47	11.7	82,485.00	17.95
18	18	4.5	54,586.80	11.86
21	10	2.5	48,157.00	10.48
24	6	1.5	43,051.00	9.34
27	5	1.2	51,175.00	11.15
30	3	0.7	42,120.00	9.10
36	2	0.5	48,522.00	10.54
<36	13	3.2	------	----
TOTALS	400		459,431.26	99.81

Droplet size distribution for High Fog #60
Kerosene-Xylene-DDT



Droplet size distribution for Hudson Hand Sprayer
Kerosene-Xylene-DDT



DISCUSSION

An attempt has been made in the present experiments to assess the deposit of DDT with the various methods of application and, furthermore, to study the relation of droplet size to deposit and the relation of deposit to toxicity.

Using the dye-tracer method with the aircraft application a deposit was obtained ranging between 0.40 lbs/acre and 0.58 lbs/acre, or an average of 0.54 lbs/acre (Table I). A chemical analysis of the deposit collected from slides showed a deposit of 0.17 lbs/acre to 0.60 lbs/acre, or an average of 0.372 lbs/acre (Table II).

No attempt was made to determine the deposits at each point of sampling in the swath due to the difficulty in obtaining samples at the desired localities. Therefore, the values given above represent a randomized sampling.

The droplet size spectrum for aircraft showed a range of 3-48 microns with a peak of 15 microns representing 18.5 vol. % (Table V). There can be no doubt that these values are low, and this may be due to the fact that the droplets were measured two days after their collection.

The analysis of deposit by the dye-tracer method for the Diesel-DDT formula using the Buffalo turbine showed a deposit of 0.70 lbs/acre at 30 ft. from the sprayer; 0.325 lbs/acre at 50 ft. and 0.239 lbs/acre at 100 ft. from the sprayer (Table III).

For the kerosene-DDT formula the deposit was 1.275 lbs/acre at 25 ft., 0.183 lbs/acre at 65 ft., and 0.102 lbs/acre at 150 ft. from the sprayer (Table III).

Correspondingly, the droplet size distribution for the Diesel formula showed a range of 3-30 microns with a peak of 15 microns representing 20 vol. % at a distance of 35 ft. from the sprayer (Table VI) and a range of 3-24 microns with a peak of 12 microns representing 23.5 vol. % at a distance of 75 ft. from the sprayer (Table VIII).

With the kerosene formula the droplet size range was 3-48 microns with a peak of 24 microns representing 16.0 vol. % at a distance of 35 ft. from the sprayer (Table VII), and a range of 3-36 microns with a peak of 18 microns representing 18.6 vol. % at 75 ft. from the sprayer (Table IX).

The above results indicate three things:
1) That droplet size decreases as the distance away from the sprayer increases.

2) That total deposit decreases with a decrease in droplet size.
3) That droplet size depends, among other factors, on the physical properties of the carrier used in the spray mixture.
This is clearly seen from the fact that the diesel formula gave a range of smaller droplets than the kerosene formula under the same conditions.

Evaluation of the results with the High-Fog and Hudson hand sprayers was done only in connection with the Bio-assay of the residual effect of DDT and this is discussed in Part II of this report.

Acknowledgements

The writer is greatly indebted to Prof. W. M. Hoskins for valuable suggestions and assistance in the determination of spray deposits. Special acknowledgement is due to Dr. R. C. Hall for much assistance and guidance throughout the experiments.

The writer also wishes to express many thanks to Mr. P. S. Messenger, research assistant in Insect Toxicology at the University of California, for making the chemical analyses of DDT deposits.

PART II

Bio-assay of the residual effect of DDT for the control of the Pine Reproduction Weevil, Cylindrocopturus eatoni Buch.

Introduction

The following experiments were designed to test the residual effect of DDT in the control of the Pine Reproduction Weevil Cylindrocopturus eatoni, Buch. The experiments covered a period of 5 weeks from July 14, 1947 to August 18, 1947 and extended over a period of two months since the spraying was done.

The object in mind was to assess the effectiveness of the DDT residues from the various formulae used, and to find out the cheapest and most effective method of application for that particular type of terrain. It was also intended to correlate the amount of deposit to mortality, but unfortunately this phase of the work could not be carried out because the available trees for sampling were not always in the desired locality from the standpoint of deposit.

As reported previously, the spraying was done with three different formulae; formula A consisting of 15% DDT in Diesel oil #2 applied at a rate of 1 gallon/acre; formula A' consisting of 15% DDT in kerosene applied at a rate of 1 gallon/acre; and formula B consisting of 7.5% DDT in water applied at a rate of 2 gallons/acre.

Procedure

The method used in the bio-assay of the residual effect of DDT was to place a sprayed branch, 6 to 8 inches long, into a cage made out of a one gallon capacity tin can. Three vertical openings approximately 5" in width, alternating with 1" strips for supports, were cut into the can, and these openings were covered with cheese cloth. The top of the can was cut off entirely and a hole 1/2" in diameter was drilled in the center of the base, which provided an outlet for the stem. The branch was then secured in the cage and the cage was placed on top of a pint jar filled with water to keep the branch fresh. Twenty to twenty-five weevils were introduced in each cage and the open top was covered with cheese cloth secured by a rubber band.

The weevils were freshly collected for each experiment from unsprayed trees in the check area. Fresh branches were used in each experiment, which were collected at random from each experimental plot. Mortality counts were taken at 24 hour intervals for a period of 72 hours. At the end of the period the cages were cleaned and the experiment was repeated.

BIO-ASSAY OF THE RESIDUAL EFFECT
OF DDT IN THE BURNEY PLANTATION.

Type of application - Hudson & Brown hand sprayers

TABLE I — Series A — 7/14/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1a	A	25	9	17	22	36	68	88
1b	A	"	19	23	24	76	92	96
2a	2A	"	15	24	25	60	96	100
2b	2A	"	17	20	23	68	80	92
3a	A'	"	12	22	23	48	88	92
3b	A'	"	7	17	21	28	68	84
4a	2A'	"	7	22	24	28	88	96
4b	2A'	"	3	13	19	12	52	76
5a	B	"	4	11	16	16	44	64
5b	B	"	5	18	20	20	72	80
6a	Check	"	2	4	5	8	16	20
6b	Check	"	1	5	5	4	20	20

TABLE II — Series B — 7/21/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1a	A	25	10	17	24	40	68	96
1b	A	"	9	21	22	36	84	88
2a	2A	"	8	22	24	32	88	96
2b	2A	"	10	25	25	40	100	100
3a	A'	"	10	21	21	40	84	84
3b	A'	"	6	12	18	24	48	72
4a	2A'	"	7	17	22	28	68	88
4b	2A'	"	3	12	14	12	48	56
5a	B	"	3	8	11	12	32	44
5b	B	"	4	16	18	16	64	72
6a	Check	"	0	2	2	0	8	8
6b	Check	"	2	3	3	8	12	12

TABLE III — Series C — 8/16/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1	A	20	12	16	20	60	80	100
2	A	"	10	15	20	50	75	100
3	A	"	11	16	20	55	80	100
4	A	"	15	18	20	75	90	100
5	A	"	12	18	20	60	90	100
6	A	"	8	14	20	40	70	100
7	Check	"	3	5	6	15	25	30
8	Check	"	3	6	7	15	30	35

Legend:
Formula A - 15% DDT in Diesel applied at a rate of 1 gal./acre.
Formula 2A - 15% DDT in Diesel applied at a rate of 2 gal./acre.
Formula A' - 15% DDT in Kerosene applied at a rate of 1 gal./acre.
Formula 2A' - 15% DDT in Kerosene applied at a rate of 2 gal./acre.
Formula B - 7.5% DDT in Water Emusion spplied at a rate of 2 gal./acre.

Type of application - Buffalo Turbine

TABLE IV — Series D — 7/14/47

Sample Number	Formula	No. of Insects	Number of dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1a	A	25	3	18	20	12	72	80
1b	A	"	5	14	18	20	56	72
2a	A'	"	3	11	17	12	44	68
2b	A'	"	3	14	19	12	56	76
3a	B	"	3	9	14	12	36	56
3b	B	"	4	6	13	16	24	52
4a	Check	"	2	4	4	8	16	16
4b	Check	"	1	2	3	4	8	12

TABLE V — Series E — 7/21/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1a	A	25	5	17	22	20	68	88
1b	A	"	9	17	23	36	68	92
2a	A'	"	6	16	20	24	64	80
2b	A'	"	3	9	15	12	36	60
3a	B	"	5	13	20	20	52	80
3b	B	"	3	12	18	12	48	72
4a	Check	"	0	2	2	0	8	8
4b	Check	"	2	3	3	8	12	12

TABLE VI — Series F — 8/16/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1	A	20	12	17	20	60	85	100
2	A	"	10	16	20	50	80	100
3	A	"	12	15	20	60	75	100
4	A	"	9	14	20	45	70	100
5	A	"	13	18	20	65	90	100
6	A	"	7	15	20	35	75	100
7	B	"	12	17	20	60	85	100
8	B	"	13	16	20	65	80	100
9	B	"	9	15	20	45	75	100
10	B	"	14	19	20	70	95	100
11	B	"	10	14	20	50	70	100
12	B	"	12	16	20	60	80	100
13	Check	"	3	5	6	15	25	30
14	Check	"	4	5	7	20	25	35

BIO-ASSAY OF THE RESIDUAL EFFECT OF DDT IN THE MT. SHASTA PLANTATION

Type of application - Hudson & Brown hand sprayers

TABLE VII — Series G — 7/14/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1	A	25	5	9	15	20	36	60
2	A	"	8	12	18	32	48	72
								7/21/47
3	A	"	7	13	22	28	52	88
4	A	"	10	19	24	40	76	96
								7/31/47
5	A	20	5	8	14	25	40	70
6	A	"	7	10	17	35	50	85
								8/5/47
7	A	"	6	11	16	30	55	80
8	A	"	5	13	15	25	65	75

Type of application - N3N Aircraft

TABLE VIII — Series H — 7/14/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1	A	25	6	9	16	24	37	64
2	A	"	8	10	15	32	40	60
3	Check	"	3	4	4	12	16	16
4	Check	"	3	3	4	12	12	16

TABLE IX — Series I — 7/21/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1	A	25	5	10	18	20	40	72
2	A	"	9	12	20	36	48	80
3	Check	"	1	3	4	4	12	16
4	Check	"	1	2	3	4	8	12

TABLE X — Series J — 7/31/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1	A	20	2	7	15	10	35	75
2	A	"	3	9	16	15	45	80
3	A	"	3	10	13	15	50	65
4	A	"	6	12	15	30	60	75
5	A	"	3	8	10	15	40	50

TABLE X (continued)

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
6	A	20	6	14	16	30	70	80
7	A	"	4	8	11	20	40	55
8	A	"	3	7	10	15	35	50
9	A	"	4	13	16	20	65	80
10	A	"	5	12	18	25	60	90
11	A	"	5	12	14	25	60	70
12	A	"	7	13	17	35	65	85
13	A	"	3	11	16	15	55	80
14	A	"	4	9	15	20	45	75
15	A	"	3	8	12	15	40	60
16	A	"	5	15	18	25	75	90
17	A	"	4	10	16	20	50	80
18	A	"	3	7	14	15	35	70
19	Check	"	1	3	3	5	15	15
20	Check	"	0	2	4	0	10	20
21	Check	"	1	3	5	5	15	25
22	Check	"	0	0	1	0	0	5

TABLE XI Series K 8/5/47

Sample Number	Formula	No. of Insects	Number of Dead			% Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
1	A	20	5	12	16	25	60	80
2	A	"	3	8	12	15	40	60
3	A	"	3	12	18	15	60	90
4	A	"	2	13	16	10	65	80
5	A	"	3	7	13	15	35	65
6	A	"	2	9	14	10	45	70
7	A	"	5	10	13	25	50	65
8	A	"	4	14	18	20	70	90
9	A	"	4	12	16	20	60	80
10	A	"	3	13	18	15	65	90
11	A	"	3	12	17	15	60	85
12	A	"	8	14	17	40	70	85
13	Check	"	3	5	5	15	25	25
14	Check	"	2	4	4	10	20	20
15	Check	"	2	4	5	10	20	25

Summary of Bio-assay of the Residual Effect
of DDT in Burney Springs and Mt. Shasta Brushfields.

(Based on Tables I, II, IV, V, VII, VIII, IX, X, XI)

TABLE XII

Type of Application	Formula	Total No. of Insects	Total No. of Dead			Average % Kill		
			24 hrs.	48 hrs.	72 hrs.	24 hrs.	48 hrs.	72 hrs.
Hand	A	240	89	149	202	36.8	61.4	83.4
Hand	A'	100	35	72	83	35.0	72.0	83.0
Hand	B	100	16	53	65	16.0	53.0	65.0
Turbine	A	100	22	66	83	22.0	66.0	83.0
Turbine	A'	100	15	50	71	15.0	50.0	71.0
Turbine	B	100	13	40	65	13.0	40.0	65.0
Aircraft	A	700	145	362	519	20.6	52.0	74.3
Check	-	440	27	58	68	6.1	13.3	15.9

Discussion

An analysis of the data obtained indicates that a fair degree of control was obtained throughout the period of July 14 to August 17, i.e., between one and two months after the spraying was done. However, some slight and some marked variations occurred with the different formulae used and with the various types of application.

Not much difference was found between formulae A and A', applied with the Hudson and Brown hand sprayers. While formula A (DDT- Diesel) gave an average kill of 36.4%, 61.4%, and 83.4% for 24, 48, and 72 hours respectively, the average kill for the A' formula (DDT-Kerosene) was 35%, 72%, and 83% for 24, 48, and 72 hours respectively (Tables I, II, and XII). With this type of application there is apparently not much variation in deposit and residual effect.

On the other hand, formula B (DDT-water emulsion) was inferior and showed only an average kill of 16%, 53%, and 65% for 24, 48, and 72 hours respectively (Tables I, II, and XII). This is due primarily to the inferior wetting quality of pine needles by a water emulsionof DDT leading to a lower and less uniform deposit. In contrast formulae A and A' caused a slight burning of pine needles while no such burning occurred with formula B.

Several trials were made with a double dose of formulae A and A', i.e., 15% DDT in Diesel or Kerosene applied at a rate of 2 gallons/acre. No appreciable difference in mortality was found by doubling the dose (Tables I, II, XII). Apparently sufficient deposit was obtained with the single dose to give an average mortality of more than 80%.

The results with the Buffalo Turbine application showed a similar behavior. No marked difference in mortality was obtained between formulae A and A' (Tables IV, V, XII), although the average deposit of DDT-Kerosene was higher and more irregular than that of DDT-Diesel.

Formula B (water emulsion of DDT) again, as in the previous case, gave a lower average mortality (Tables IV, V, XII).

The application by airccaft was by far the most uniform. Although the average mortality was slightly lower than that obtained with the corresponding formulae of the other types of application, it was, nevertheless, significant (Tables VIII, IX, X, XI, XII).

A point of interest is the fact that in the last experiment done on August 16 the mortality was much higher than in previous cases (Tables III, VI). This can be explained on the basis of weevil population studies in the Burney plantation. While a weevil population census from the unsprayed area, taken at frequent intervals between June 15 and July 31, showed an average of more than fifty weevils per tree, (in a record case 395 weevils were collected from a small pine tree) the population count taken on August 15 showed less than fifteen

weevils per tree. It is possible, then, that at this stage of a diminishing population the remaining weevils show greater susceptibility to DDT residues. However, it is to be noted that the checks, also, gave a higher mortality than in previous cases (Tables III, VI), so that the higher mortality obtained with the insecticide can be attributed to a higher natural mortality.

The last population count made on September 6 showed an average of 5.2 weevils per tree.

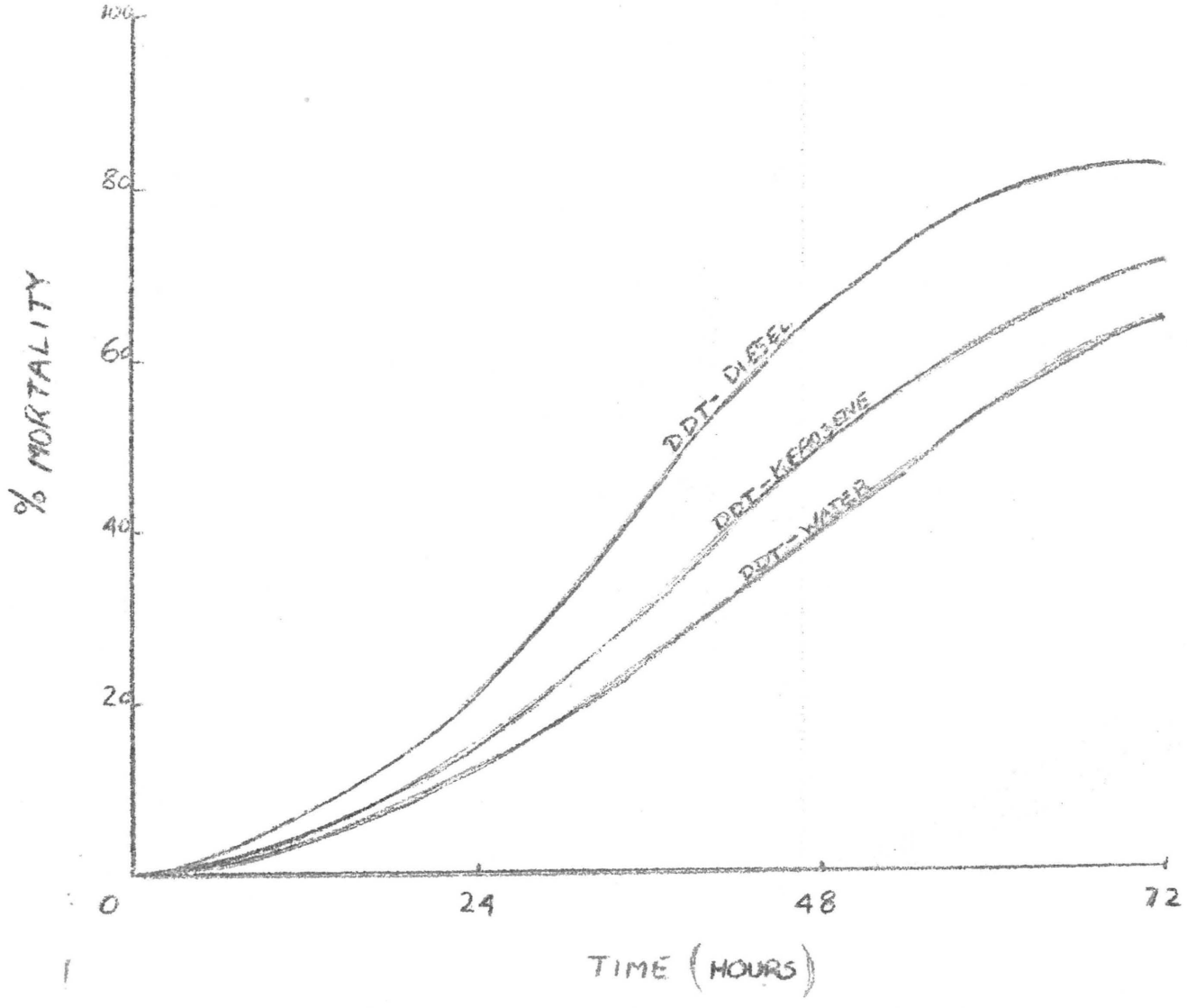
Conclusions

On the basis of the data obtained under the conditions of the tests it is apparent that good control can be obtained from DDT residues over a period of two months and longer. The chemical weathers very well and it is safe to assume that one application would be sufficient under the climatic conditions of Burney Springs and Mt. Shasta areas.

This coupled with the high initial kill obtained can no doubt give a satisfactory measure of control in reducing the weevil population below the level at which it is considered a pest.

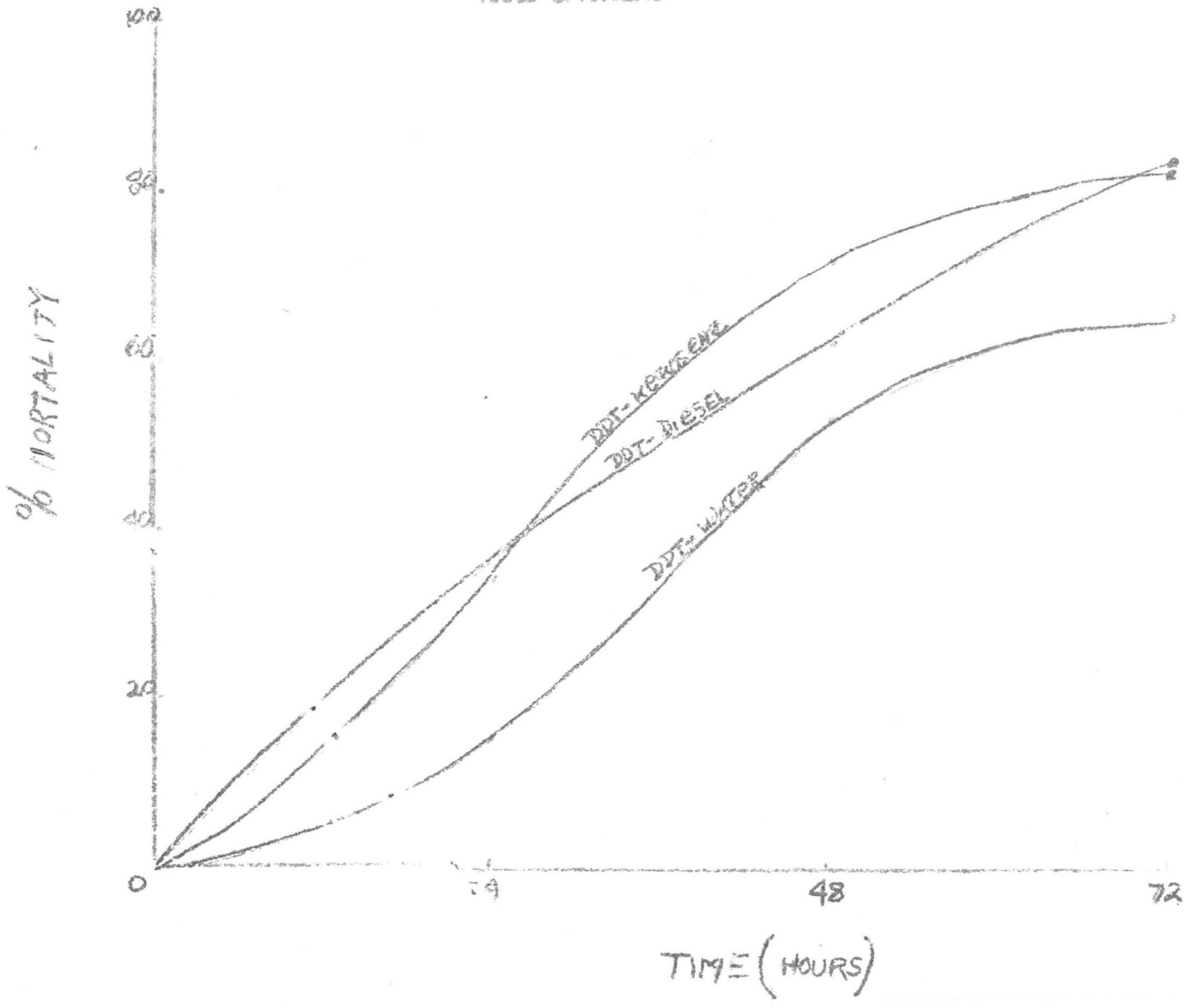
TIME - MORTALITY CURVE

BUFFALO-TURBINE



TIME - MORTALITY CURVE

HUDSON & BROWN
HAND SPRAYERS



TIME - MORTALITY CURVE
FOR
DDT - DIESEL
WITH VARIOUS TYPES OF APPLICATIONS